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Penberthy Electromelt International, Inc.
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Seattle, Washington 98108, U.S.A.
Phone 206/762-4244
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November 15, 1994

DEC 1994

Pam Innis
U.S. Environmental Protection Agency
712 Swift Ave, Suite 5
Richland, WA 99352

**Re: Environmental Restoration Disposal Facility (ERDF) Objection**

Dear Ms. Innis:

The proposal to landfill hazardous (chemical), low-level radioactive, and mixed wastes is a bad idea. Not only bad, it is obsolete.

In case you hadn't noticed, landfills for hazwaste have gone out of style. If this project is carried out, the net result will be another Superfund site, hugely-expensive to clean up.

The far superior way to handle these wastes is to use a Penberthy Pyro-Converter[tm] furnace which includes a pool of molten glass, kept hot electrically. The functions are:

1. Water is vaporized at 2200°F (1200°C), at which temperature any organic chemical content is destroyed and oxidized or reduced.

2. Combustible chemicals are destroyed by pyrolysis followed by combustion to form carbon dioxide, water vapor, and hydrogen chloride.

3. Mineral components and residues are converted (melted) into the glass, where they are permanently sequestered.

Radioactive elements are made into vitreous silicate, and are insoluble forever. The glass is radioactive, but is not available to the biosphere.

One big advantage of the process is volume reduction. The volume of the original waste is reduced to 10% as glass.

This process for hazwaste has already been proven by destruction of 1,300 tons of RCRA wastes.

Both furnaces and licenses under U.S. Pat. 4,299,611 are readily available in capacities from 4 tons per day to 100 tons per day.

Bulletins Pyro 31 and 48 describe the process.

Sincerely,

Larry Penberthy

Larry Penberthy

LP/nd
Enc: Pyro 31, 48

HANFORD PROJECT OFFICE
NOV 18 1994
ENVIRONMENTAL PROTECTION AGENCY

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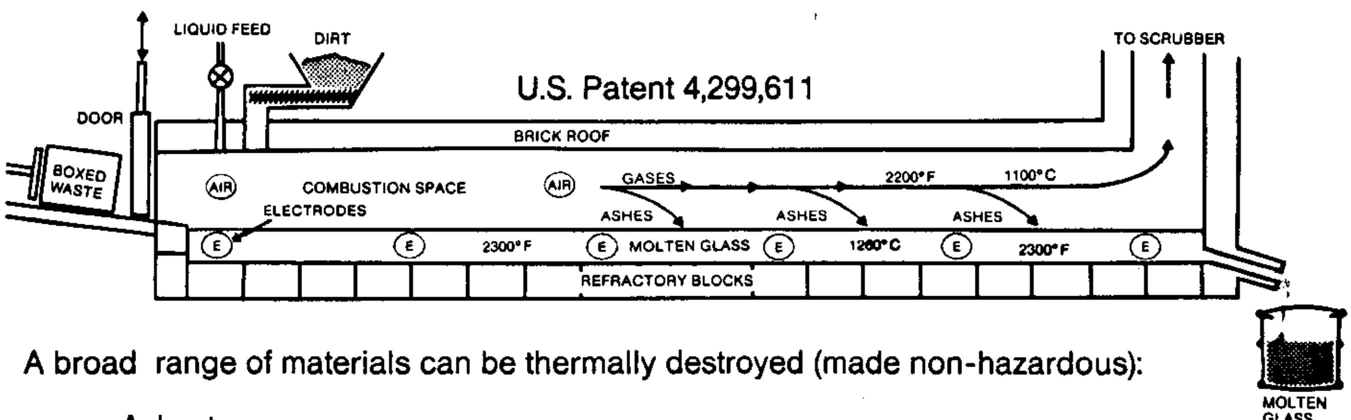
# The Penberthy PYRO-CONVERTER™
## Molten Glass Detoxifier Furnace

The Penberthy Pyro-Converter™ electric molten glass furnace is a thermal redox reactor which converts a wide range of hazardous waste materials into simple non-hazardous compounds: chiefly carbon dioxide, calcium chloride, and inert stable glass.

The necessary high temperature is maintained electrically by passage of electric current through the glass between immersed electrodes. This is resistance heating; there is no arc.

Organic materials fed into the furnace are subjected to intense heat (2300°F) in the presence of air and water vapor. Chlorine is reduced to hydrogen chloride and converted to $CaCl_2$; carbon is oxidized to carbon dioxide; mineral residues are melted into glass.




A broad range of materials can be thermally destroyed (made non-hazardous):

Asbestos
Arc Furnace Dust
Incinerator Ashes
Contaminated Soil
All Chloro Organics
Paint Solvents and Sludges
Electroplating Sludges
Military Wastes

Pot Liner from Aluminum
Sludges from:
    Water purification,
    Municipal sewage
* In-Plant wastes, all kinds
Superfund remedial, including
    soil and lagoon mud

Bio-Medical
Pesticides

The Penberthy Pyro-Converter Furnace is not an incinerator. It does not use a controlled flame and does not produce ashes. Glass is the only solid end product.

We see a large market for the PYRO-CONVERTER furnace, both in manufacture and sale of furnaces and in their operation, both in plant on a dedicated basis and at central facilities on a commercial basis. We are already thermally destroying hazardous materials at our plant in Seattle. We seek major partners for the rest of the country and abroad.

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# Penberthy Molten Glass Process for the Destruction/Sequestering of Mixed Chemical/Radioactive Wastes

**by Larry Penberthy**
**Penberthy Electromelt Int'l, Inc.**
**Seattle, Washington**

## DESCRIPTION

The Penberthy Molten Glass Process for the destruction/sequestering of Mixed chemical/radioactive wastes is based on the electric glassmelting technology using rod molybdenum electrodes, originated in 1952. Application of this basic technology has spread worldwide, melting in total an estimated 40,000 tons of glass per day. The basic technology is well proven.

Figure 1 shows the vertical longitudinal section of the furnace. The walls are special refractory brick in a steel casing. The lower sidewalls contain a pool of molten glass. The upper sidewalls and roof form a combustion chamber. Wastes are introduced into one end of the tunnel and redox offgas and molten glass exit from the other.

The molten glass is kept at the desired temperature (around 2200-2400°F) by a combination of electric heat and combustion heat. The electric heat is generated in the glass by the flow of current through the glass by resistive conduction between immersed electrodes. (Molten glass is a conductor of electricity, about the same as saltwater is at room temperature.)

The combustion heat comes from the waste material as it burns with admitted air. The higher the heat value of the waste, the less electric energy is used.

Residual mineral-type material from the waste (called ashes if from an incinerator) falls onto the hot glass surface and dissolves in the glass. Excess glass is tapped out as needed to maintain level.

The offgases pass through a scrubbing system described below.

## CHEMISTRY -- OXIDATIVE, THERMAL

Glassmelting is commonly done at temperatures around 2400° to 2600°F. At these temperatures, organic chemicals crack (pyrolyze) instantly. The gaseous environment in which this takes place is of major importance re offgas components and scrubbing requirements.

Fig. 2 shows the structure of PCB. Temperature cracks the carbon-carbon bond at which instant the carbons are highly reactive with oxygen. The Penberthy Molten Glass Process uses controlled air admitted along the length of the tunnel to be sure of maintaining a high oxygen availability to the open carbons. They oxidize, thus breaking the benzene rings. Once broken, the rings do not re-form.

This permanent destruction of the benzene rings is of great onward importance in the prevention of formation of dioxins and furans (Fig 3). From the literature, I doubt that dioxins and furans are a health hazard in trace amounts, but since the public, media and regulators seem to think they are important, we as manufacturers of furnaces have to meet the perceived need. This is done by maintaining high oxygen conditions, above 10%, and high temperature.

Carbon monoxide in the offgas is monitored, and is normally 10 to 20 ppm. This is taken as an indicator of excellent Destruction Efficiency, which has been confirmed by GC-MS stack gas analysis showing six nines DE for trichloroethylene and trichlorobenzene.

In addition to the oxygen, reactive hydrogen is needed to combine with the chloro atoms to form hydrogen chloride. This hydrogen is obtained from the waste itself or from added hydrocarbon fuel or from injected steam.

Other organic compounds are converted to simple gases ($CO_2$, $H_2O$, HCl and the like) in the same general manner.

<u>OFFGAS CLEANING</u>

The offgases pass through a scrubber system (Fig. 4) that takes various forms according to the need. When there is no radioactivity, the gases are first partly-cooled in a duct which may have water-cooled walls. They then pass upward through a series of towers which are packed with rock limestone.

Recirculated water passes downwardly over the rock, whereby acid gases are absorbed by the water and neutralized by the limestone. The neutralized salts are discharged to the municipal sewer.

When the radionuclides cesium and strontium are present in the feed, a hot filter system is used (Fig. 5). In a duct immediately out of the furnace, fiber glass filters pick up much of the dust and fume. When the filters are loaded, each filter unit in turn is pushed into the furnace where it melts, returning the dust back to the pool of glass.

<u>MINERAL RESIDUES</u>

Mineral residues of the feedstock after combustion of the organics originate from several sources: metal components of chemicals, such as lead, sodium, chromium, nickel, iron; actual soil; paper sizing; wood ash and the like. In the flame, they are converted to oxides (if not already) which are generally compatible with glass formation. The ratios of the various oxides have to be balanced in the glass formation region by addition of chosen additives, generally silica and soda.

The resulting glass is inert chemically and is insoluble. We hand out small bars of such glass as paperweights/souvenirs.

RADIONUCLIDES

Many of the fission products from nuclear fuel are radioactive and are elements capable of forming stable oxides. Examples: cesium, strontium, nickel, iron, cobalt. These oxides are compatible with glass formation, and are dissolved in the glass. The resulting glass is inert chemically and is insoluble, but now is radioactive.

Gamma radiation must be guarded against by shielding and remote operation of the furnace. Beta radiation is absorbed in the glass, except from the surface layer. Alpha radiation is completely absorbed in the glass.

We have melted radium contaminated soils into a stable glass. There was perfect capture of radon and alpha particles down the decay chain to stable lead.

Uranium, thorium and the rare earths are also compatible with glass structure. I expect the same to be true for plutonium and transuranic elements.

As a result of recovery of uranium and plutonium from irradiated fuel, large quantities of fission products remain in tanks at Hanford and Savannah River. There is a large opportunity to lower the cost of stabilizing these fission products by adding silica and lime and melting the mixture into Class C low level waste. This glass is insoluble and can be buried at low level burial sites.

The Department of Energy at Savannah River has chosen a very expensive separations process which results in a high level glass component which has to be sent to a high level repository, plus a low level sodium-salt/cement mix which is to be buried on site. The separations step is not complete. Accordingly the cement mix is still classified as low-level radioactive waste. The separations step can be omitted when using the Penberthy Molten Glass Process.

The comparative processes are shown in Fig. 6.

Water purifying ion exchange resins can be burned in the Molten Glass furnaces whereby the mineral components are dissolved in the glass. This results in a great volume reduction.

Low level waste from nuclear power plants, consisting mostly of paper, clothing, and the like can also be treated in the same way.

SUPERFUND SITE REMEDIATION

Various processes have been proposed for remediation of Superfund sites. Where the contamination in the soil contains heavy metals as well as vaporizable organic compounds, Dug Up Vitrification by the Penberthy Molten Glass Process has great merit. This includes digging up the soil, mixing it at the furnace with sodium carbonate, charging the mixture into the furnace, and refilling the hole with the purified granulated glass.

The advantages of Dug-Up Vitrification are:

1. The site is excavated only to the depth really needed, as determined by soil sampling.

2. Vaporizable organic compounds are destroyed without question by virtue of being charged into a closed furnace box. None can escape the heat and burning process. There cannot be any vapor retreat into surrounding cooler soil.

3. Heavy metal oxides, such as chromium, lead and cadmium are sequestered uniformly in the glass using batch blanket technology.

4. The furnace can and usually does operate continuously, 24 hours a day, 363 days a year. This maximizes the use of the capital investment.

5. The basic melting process is reliable, being industry proven over 36 years; it is melting currently about 40,000 tons of glass per day, worldwide.

6. The output glass is real glass, without crystalline inclusions or segregation or rocks. Further, the quality and composition of the glass can be ascertained continuously during processing.

If the soil chemistry changes, adjustments to the additives can be made immediately with knowledge based on glass technology.

7. Operating costs are known from the widespread use of this furnace process in the glassmelting industry. The expected cost including electric power, labor, repair and maintenance, amortization and additives ranges from $100 per ton in low power cost areas to $160 per ton in high power cost areas. Excavation is extra, estimated at $10 to $15 per ton.

8. The furnace can be located where convenient, either on or off the site.

## REVIEW

The Penberthy Molten Glass Process for destruction/sequestering of hazardous/radioactive wastes is very versatile. The organics can be destroyed with certainty, and the residuals come out as glass which is inert and insoluble. Further, the process is not incineration, which can save a lot of hassle regarding permitting.

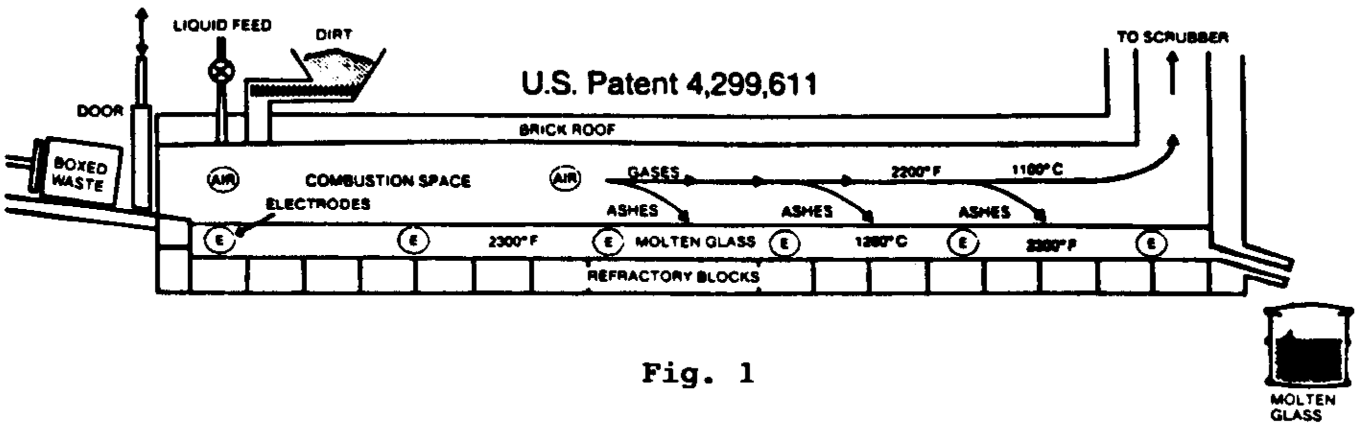


Fig. 1

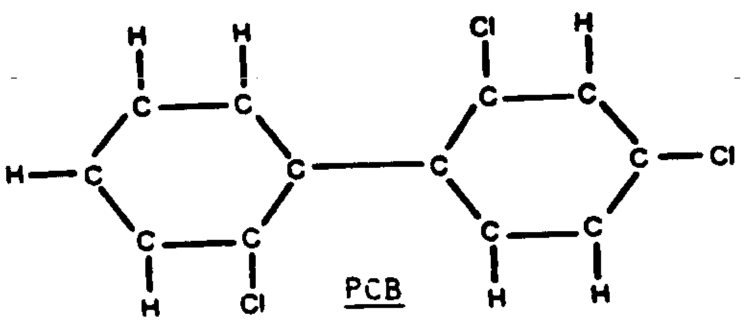


Fig. 2

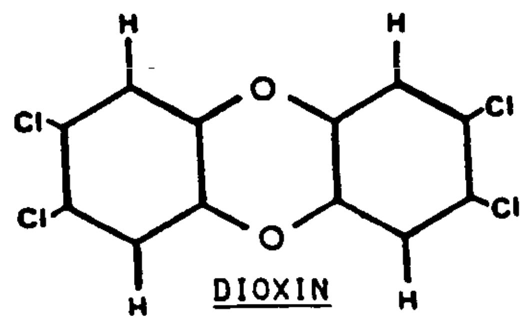


Fig. 3

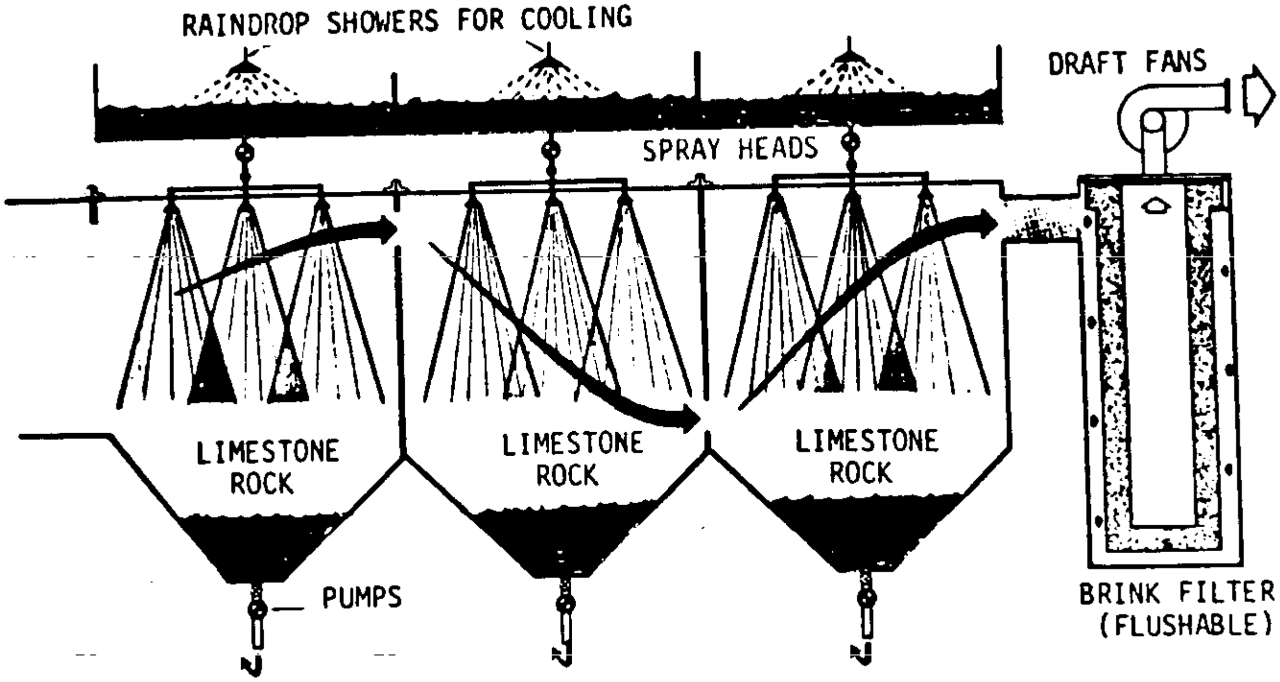
RAINDROP SHOWERS FOR COOLING
DRAFT FANS
SPRAY HEADS
LIMESTONE ROCK
LIMESTONE ROCK
LIMESTONE ROCK
PUMPS
BRINK FILTER (FLUSHABLE)

Fig. 4

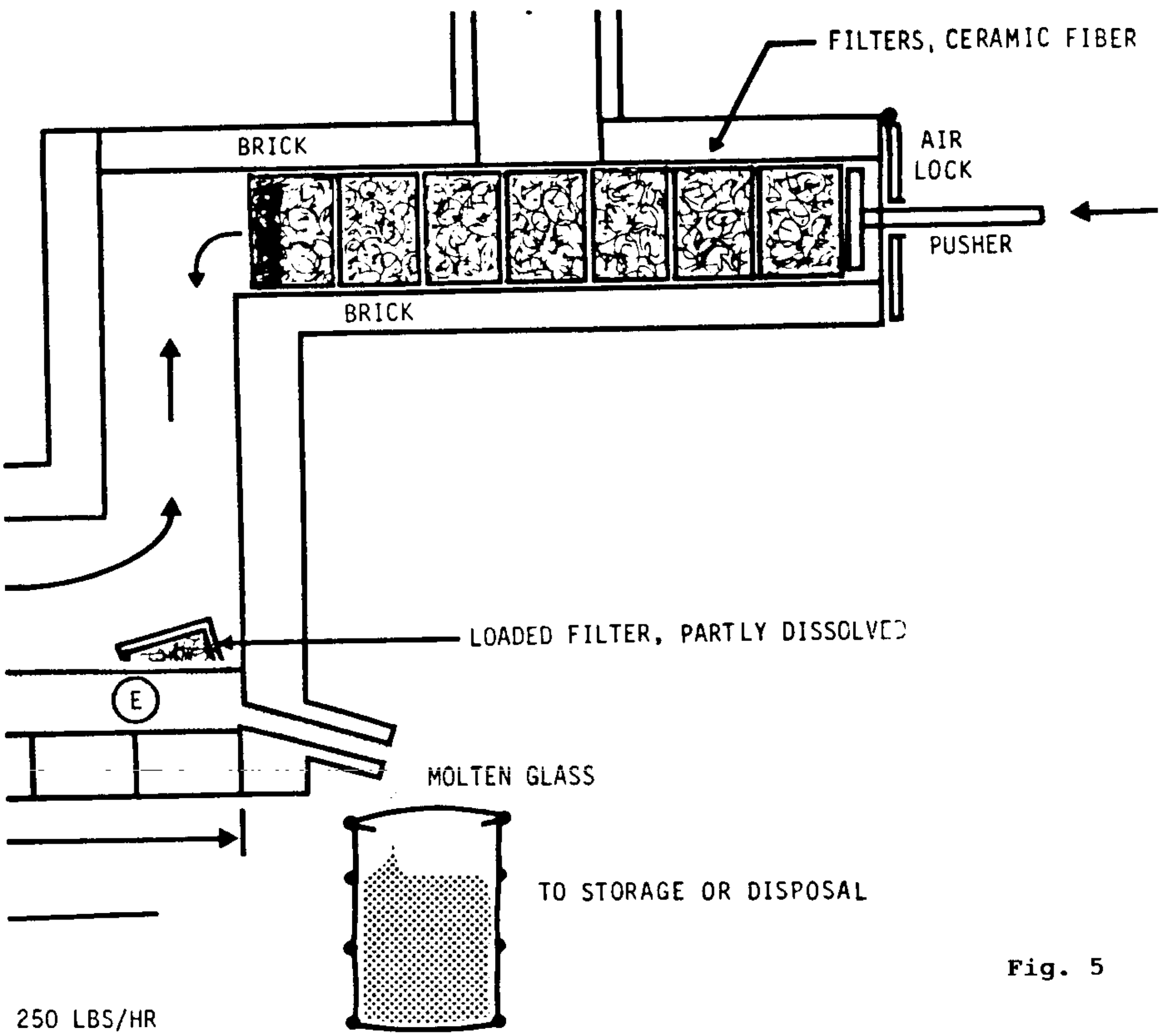
FILTERS, CERAMIC FIBER
BRICK
AIR LOCK
PUSHER
BRICK
LOADED FILTER, PARTLY DISSOLVED
E
MOLTEN GLASS
TO STORAGE OR DISPOSAL
250 LBS/HR

Fig. 5

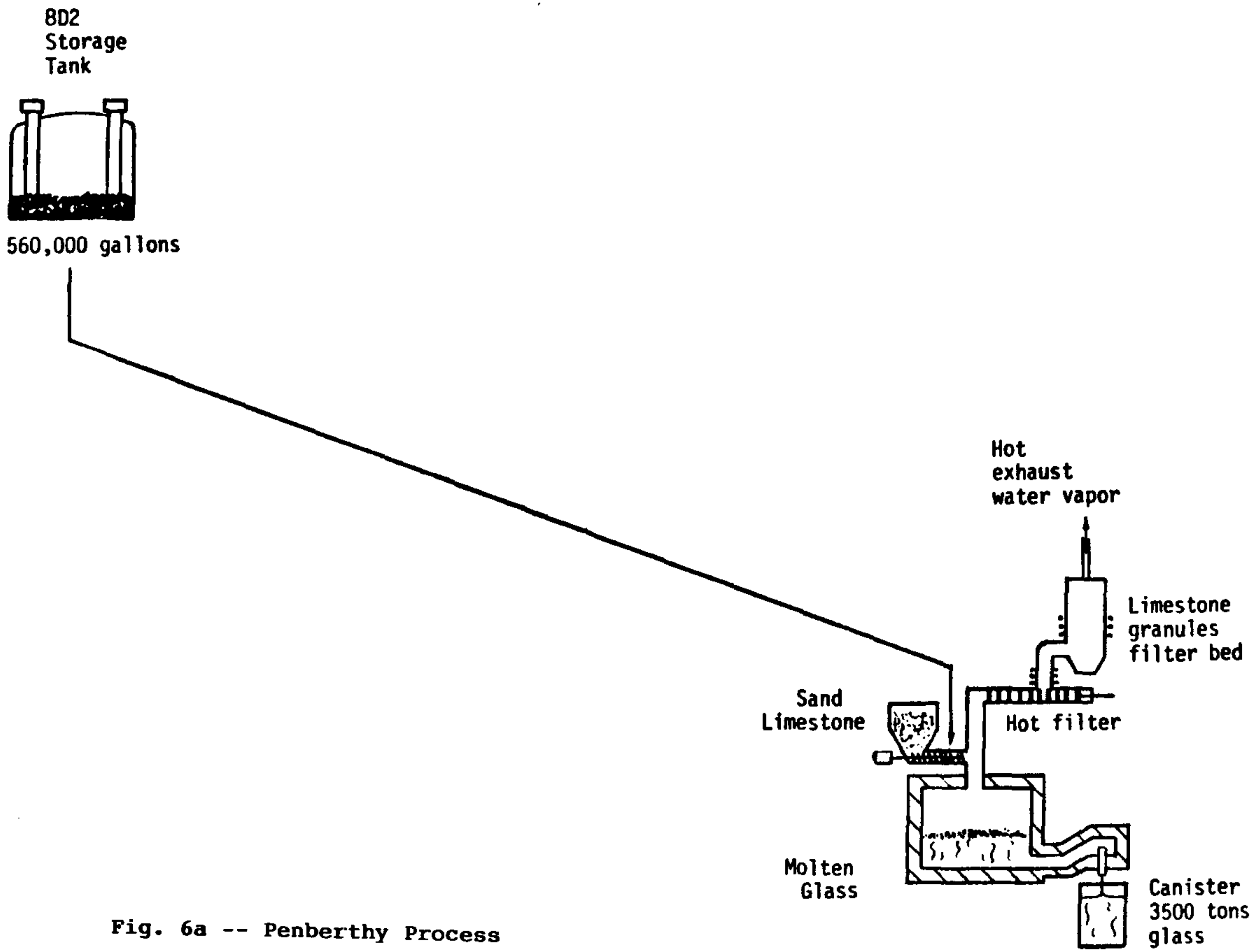


Fig. 6a -- Penberthy Process

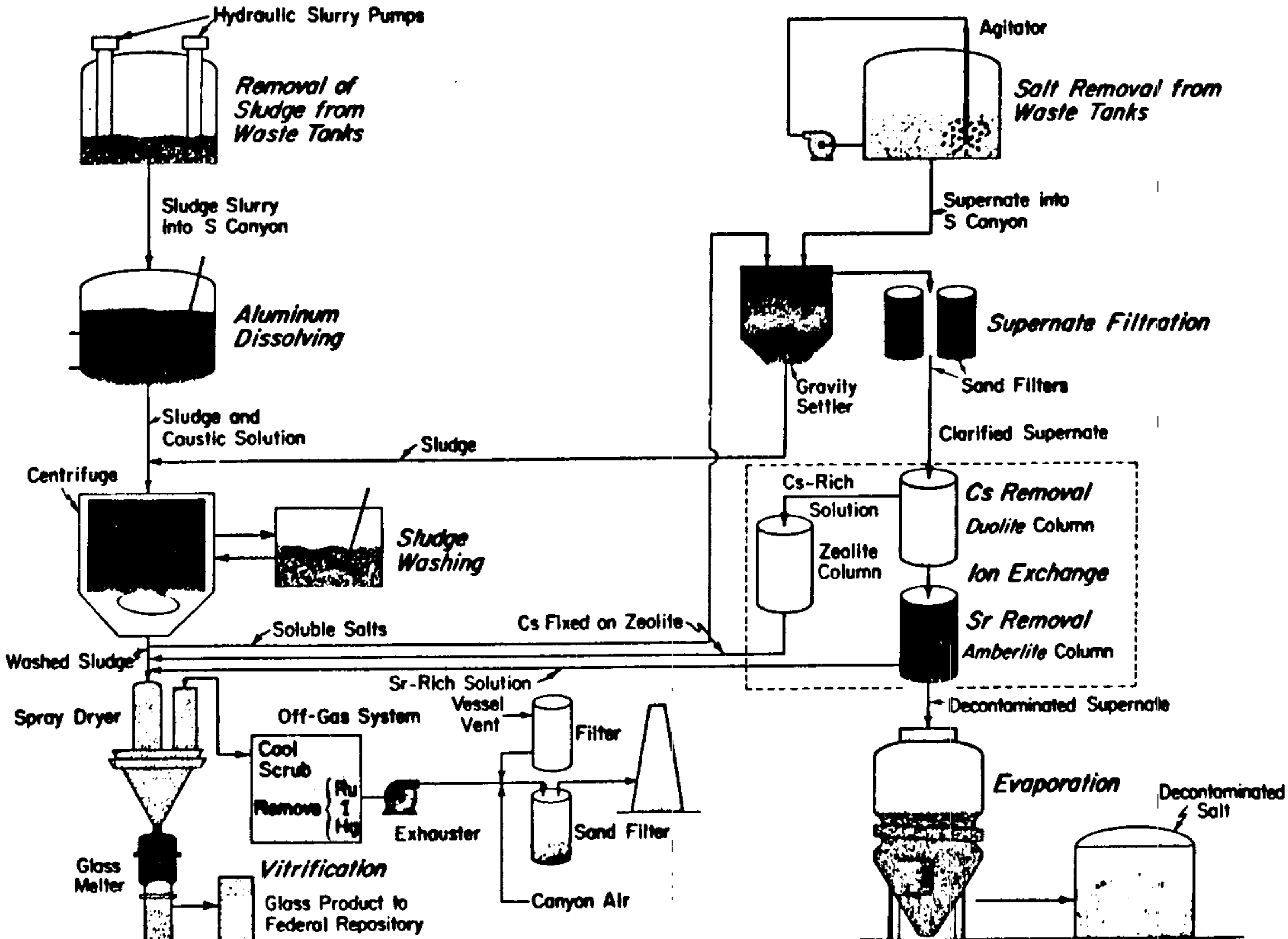


Fig. 6b. - Savannah River Process

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FROM
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